

## NOTES ON THE HABITS OF THE SNOW-FLY (CHIONEÆ).

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The interesting wingless Tipulid genus *Chionea* has often attracted the attention of entomologists because of its being one of the few insects which are found regularly at winter-time, being apparently quite at home on snow and at low temperatures. Also this genus is not without interest for the student of Parasitology, in so far as so many wingless species are found among the parasitic insects, the habits of which may be elucidated by a fuller knowledge of forms with similar characteristics.

The genus *Chionea* was described first by Dalman (1816), with the type-species *C. araneoides*, from Sweden. Later, the snow-flies have been reported from places in Scandinavia, Germany and Austria, Russia, Alsace, Switzerland and Italy; the early stages have been described by Brauer (1854), and have been found repeatedly since, being terrestrial in habit and occurring under decaying leaves in wooded regions. At first, these captures were all recorded under the heading of *Chionea araneoides* Dalm., but it appears that the true *C. araneoides*, together with a dark and thick-legged form, *C. crassipes* Boheman, occurs only in Scandinavia, Lapland and Finland, while the *Chioneæ* of Germany, Austria and part of Russia (with *araneoides*), belong to *C. lutescens* Lundstr., and those of the Swiss and Italian Alps to *C. alpina* Bezzi. The two last-mentioned species are nearly related to one another, more yellow in color, and differ from the Scandinavian forms chiefly by the antennæ which are composed of a smaller number of joints, and bear longer hairs than in the northern species. Also considerable differences have been found in the arrangement and formation of the hairs on the legs.

In America, the species *C. valga* Harris, discovered in 1835 and described in 1841, has been found repeatedly since in New England (Emerton), Minnesota (Lugger), and Canada (Gosse). Interesting notes on its habits, especially on its copulation, we owe to Lugger (1896), who observed the species in Minnesota. According to Johnson (PSYCHE, 1907, p. 41-44), it is doubtful whether there is

more than one species of *Chionea* in North America, though several have been described, but Bezzi (1913) thinks that *C. scita* Walker must be regarded as a good species.

During a sojourn in Davos, Ct. Grisons, Switzerland, at an altitude of ca. 1560 m. (4,680 feet) above sea-level, I found occasion to observe these insects, which were entirely new to me. As I find that the peculiar hibernal habits of this and some other winter-insects are not yet clearly understood, the publication of my results, however fragmentary, may be of some interest.

The first specimen, a male, was found on November 21, 1913, at Luginsland, Davos-Dorf, on a warm, sunny day, when the snow on which a crust had already formed, was softened and partly melted at the surface; and large numbers of flies of the families Tipulidæ (Trichocera), Simuliidæ, Chironomidæ (Diamesa, etc.), Mycetophilidæ, Borboridæ, Muscidæ, etc., were found alive or half-frozen on the snow, having evidently escaped from their hibernation quarters, and fallen on the snow after a brief flight in the warm afternoon sunshine. A few Trichoptera (belonging to *Psilopteryx zimmeri*, a late fall species) and spiders were also collected. It was only when I had returned home and assorted the captures, that among the spiders the *Chionea* was discovered and its systematic position among the Tipulids readily ascertained with the aid of Hueguenin's remarks on it. The specimen had, however, been killed together with the other material.

On November 24 at noon a new snow-fall set in, and a second specimen, a female, was found about 4 p. m. running over the fresh snow. This time, no other insects were seen on the snow. The locality of these captures was a comparatively dry, sunny slope of southeast exposure which in summer is covered with alpine meadows. There were no trees except a few groups of Larch-wood (*larix*), and low pines.

After it had been collected, this *Chionea* was carried about for several hours in a small glass bottle in my pocket. On my returning home, it was placed on a plate on which it started running about eagerly, attempting to climb up the margin. It was, however, invariably driven back when approached by the hand, which gave me the impression that it was the heat of the hand which caused it to change its course. A small piece of snow being placed on the plate, the *Chionea* at once climbed on it, pressing its pro-

boscis against it for a short while as if to drink, then running over it and going again on the plate. Attempting to escape, it was repeatedly driven back by the approaching hand. I noticed that my hands were rather warm. In fact, it did not stop when approached by my wife's hand which was cooler, and on which the insect would continue to run.

The specimen was kept alive and a cage constructed which permitted its observation. The cage consisted of a glass tray,

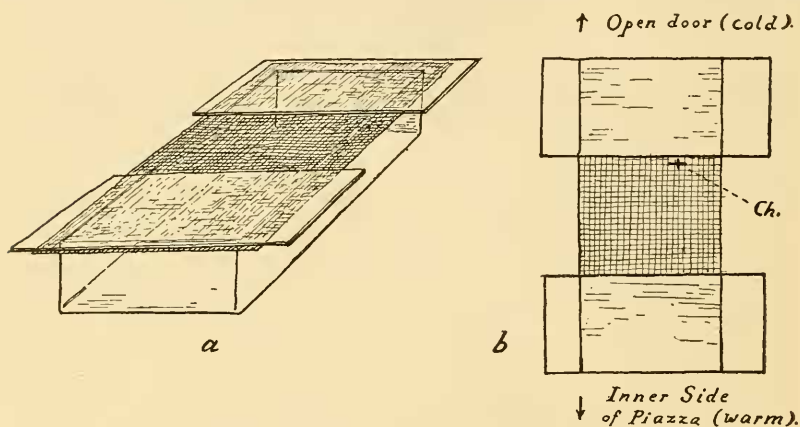


Fig. 1. Observation cage used in experiments with *Chionea*: a, general view of cage; b, same seen from above; #, habitual resting place of *Chionea*.

about one and one-half feet long, covered entirely with two glass covers, which could be replaced, wholly or in part, by wire-netting. After some experimenting, it was preferred to cover the whole with wire-netting, and in addition to this, to cover the short sides of the tray with the two pieces of glass, leaving an open space in the middle, covered only by wire-netting, as seen in the figures. The tray was, at first, half filled with sifted earth and half with snow in order to ascertain whether the insect would show a preference for one of these. It seemed equally at home on both and observations tended to show that *Chionea* is a true snow-insect, not a mere accidental one, as has been supposed by Emerton (see Johnson, *PSYCHE*, 1912, p. 102), and as all the other insects quoted above undoubtedly are.

The *Chionea* was placed on the border-line between snow and

earth. It went on the snow but soon passed over to the sifted earth without apparently showing any preference for either, the temperature being low; running for awhile over the earth on which, on account of its brownish color, it was hardly visible, it passed again on the snow and ran there approximately as long as it had on the earth. It then started, with some effort, to climb the glass walls of the cage, demonstrating the negative geotropism of most insects, and arrived on the wire-netting of the cover. In the arrangement described, it was found that the *Chionea* preferred the uncovered part of the wire-netting where the open air had access. Apparently it was seeking out the coldest spot available.

It was observed that each time when, in the course of running about on the wire-cover, it approached the part which was covered by a glass plate it stopped its straightforward course, running alongside the covered part and soon returned into the open region. Several times it went under the glass cover as if for trial, but never remained very long; while in the open region it would run about freely in various directions.

It was not ascertained with exactness how long the insect stayed in the covered nor how long in the open part, but the observations clearly show that the *Chionea* preferred the open region, which seemed to indicate that it found here its apparently very low optimum of temperature. The cage was exposed to the open air at not much above freezing temperature, in a glass veranda, the door of which was kept open.

It was found that this behavior of the *Chionea* was somewhat modified by the influence of light. On that side of cage which was in greater distance from the light, it went more often under the covering glass than on the side nearer to the light. It seemed therefore that the negative thermotropism was stronger and more pronounced in the light than in the shade.

At the same time the *Chionea* showed itself distinctly positive phototropic. The conflict between the two instincts must be strongest on the side nearer the light, as here one should expect the insect, on account of its phototropism, to go under the glass cover. However, it is in the light, that it most consistently avoids going under the shelter. As a result, its favorite place remained that part of the open region which was nearest the light and just bordering the glass cover, and it was here that the fly usually came to rest.

The cage was now turned  $180^{\circ}$ , all other conditions remaining unchanged. The *Chionea* at once demonstrated its positive phototropism by running in a straight line towards the light. Arrived at the glass-covered part, however, it turned aside without going under it. After a little while, it was seen to go under this glass cover for a short time, but soon came back and returned across the whole uncovered field, coming to rest at the edge of the other glass cover, which was now on the darker side of the cage. Left to itself, the *Chionea* would sometimes tumble down from the wire-netting of the cover, and run about for awhile on the snow or earth. However, it always soon climbed the glass wall again, and took to its former place in the open part of the cover, which, exposed to the draft, was probably colder than the snow.

To test out whether *Chionea* really preferred the open region because of its being colder, I warmed my hand by means of a hot electric light bulb, and could, by coming near it with the heated surface of the hand, drive the insect from the open field of the cover into the space under the glass cover. I concluded that the *Chionea*, as a rule, seeks out the coldest place it can possibly find. The experiment was then closed.

On November 25, in the morning, the *Chionea* was found sitting at the under surface of the glass cover which was covered with hoar-frost. The snow in the cage was partly melted, and the resulting humidity had formed an ice-crust on the glass cover. The *Chionea* seemed perfectly at ease while resting on this icy surface.

Towards noon I brought the insect out into the open air to the edge of the balcony, on which fresh snow had fallen. It was watched but otherwise left entirely to itself, and was seen running over the snow alongside the whole railing of the balcony, the direction being against the wind (positive anemotrop?). It kept itself somewhat on the inner side of the railing on the side of the house, but pursued its course in a nearly straight line. Only once it turned to the outer side and had to be driven back to prevent its falling from the balcony. Three times it went to the left (the side of the house-wall), going below the edge and to the underside of the snow-layer covering the railing, remaining quiet for a short time, but each time returned soon to the surface of the snow and continued its walk. Though on these three occasions it came near to



the place where the snow-covering bordered on the wood of the railing, the insect was never seen going on the wood, showing a well-marked preference for the snow. Arrived at the end of the balcony, the *Chionea* had to be stopped in order to prevent it from falling; this was done by approaching it with the finger, avoiding actual contact. This was found sufficient to cause it to change its course. If carefully touched with the tip of the finger, it contracted all the legs towards the body and remained quiet. After making two attempts to go in the previous direction, it finally turned to the side, and continued to run in a straight line alongside the transverse railing of the balcony in the same way as described before.

The fly was then placed in its cage, where it at once started climbing the glass walls. Shortly afterwards, at 1 p. m., it was again found sitting on the underside of the cover, this time under the glass plate. At 2.30 p. m., however, it was found to have resumed its favorite resting-place, under the wire-cover in its open part, at the edge of the anterior glass cover, that is, at the coldest spot.

On November 26, a very sunny day, observation was omitted in the morning. At 2.30 p. m. it was found that the snow in the cage was melted and the *Chionea* was lying motionless in the melting water, apparently dead. However, as I knew from my experience that drowned caterpillars may often be revived, an attempt was made to bring the *Chionea* back to life and was successful. The insect gradually began to move its legs and antennæ, until, at 4.30 p. m., it had regained its normal condition. It was then placed back in the cage.

During the efforts to revive the insect, it was kept in the heated room at least part of the time, in order to facilitate the evaporation of the water. A piece of blotting-paper was used first to absorb the excessive moisture. Blowing seemed to aid it in resuming its movements. When these had been started, however feebly, a piece of snow was brought to touch the claws of the feet, and it was noticed that each time the leg responded with a considerable reaction. In fact, snow touching the feet proved to be the strongest stimulus to cause them to move, and I conclude therefore that normally the contact of the tarsal claws with the surface of the snow is the necessary stimulus for *Chionea* to keep moving continually, as to remain on one place might cause it to freeze.

In the evening the temperature had sunk to  $-8^{\circ}$  C. and the *Chionea*, kept in the veranda at a temperature considerably below freezing, was sitting on the earth. On November 26, it was still alive sitting on the earth on that side of the cage directed towards the outer, colder side of the veranda. For several days, as the writer was ill, no observations were made. The *Chionea* was kept alive in the hope that some day a male specimen could be found which would make it possible eventually to obtain copulation and eggs. The weather was moderately cold and the cage remained in the glass veranda.

On November 29, after it had been raining all night, a very warm but cloudy day followed. The snow everywhere was sinking together. The *Chionea* remained quiet for the whole day hiding in a corner. In the evening, when the temperature had sunk again below freezing ( $-2\frac{1}{2}^{\circ}$  C.), the door of the veranda was kept open and the *Chionea* was seen creeping slowly about on the earth of the cage.

On December 2 (melting weather), snow was placed in the cage, the *Chionea* being active most of the time. At 1 p. m., the temperature had arisen to  $6^{\circ}$  C., and the *Chionea* was very lively, running about in its cage. On December 4, a violent "Foehn"—storm set in, and, unfortunately, no trace of the *Chionea* could be found, the strong wind having blown the cover partly from the cage, which permitted the insect to escape. It had lived ten days in captivity, apparently without taking any food other than snow-water.

My disappointment over the loss of my interesting object of observation was great, and it was with mixed feelings when on December 7, after an abundant snow-fall, I found two male *Chionea*, at about 11 a. m., on the snow, somewhat below the spot where the two previous specimens had been found. These males were both larger than the first one found on November 22, and very lively. In spite of a careful search, no females were found and the hope of bringing about a copulation had to be abandoned. The two males perished within the next few days and no further specimens could be obtained.

On December 8, the first of the males died in consequence of exposure to sunlight. As the fresh snow-fall was followed by bright, sunny weather, the temperature in the glass veranda and in the

glass cage had apparently become too high; however this may be, the insect was found dead in the cage in the direct sunlight. The other specimen had remained in the shade. In the evening, the temperature fell to  $-11^{\circ}$  C., and being curious to know whether the *Chionea* would withstand such low temperatures, I left the glass door of the veranda open over night. On the morning of December 9, the second *Chionea* was dead, apparently killed by frost, after the fashion of the famous tamed herring which had learned to walk about and breathe air but one day fell into a pond and was drowned. The adaptation to cold has evidently its limits even in *Chionea*, and this insect, although it has its most active stage at low temperatures, seems to withstand freezing less than many other insects which at low temperatures become entirely passive.

The possibility that the males have normally a shorter life than the females should, however, be taken into consideration, and may partly account for their rapid death. The factor of humidity may also be of importance, and death in the bright sunlight may be due to increased evaporation as well as to the temperature.

#### CONCLUSIONS.

*Chionea* is not an accidental guest on the snow but perfectly adapted to life on the snow by its habits. This is evident from the fact that it can move about on snow for a practically indefinite time without being frozen, while most other insects which may be collected on the snow have been carried there by air currents or attracted by the strong light, but do not run about on the snow and usually perish within a few hours on the spot where they have fallen. Furthermore, the *Chionea* regularly drinks water from the snow by pressing its proboscis against it as was repeatedly observed.

*Chionea* is attracted to the snow:

- (1) By the bright light and white color of the snow (+phototropism);
- (2) By a thermotropic reaction which is, in itself, stronger than the phototropic reaction and which increases in the light (—thermotropism);
- (3) By the peculiar contact of the snow and a direct stimulus resulting from the action of cold on the claws (special temperature-sensibility?).



I have made an attempt, on the basis of these meagre data, to gain an idea of the ecology of *Chionea* in Nature. What is the biological significance of its living on the snow? Food is apparently not taken, hence the quest of food cannot be the purpose. The larval stage can naturally not live on the snow. Consequently, I assume that the ecological significance of the nivicole adaptation is that it affords to these wingless insects an opportunity for the sexes to meet, the considerable distances which may be covered on the snow supplanting in a measure the function of the wings, especially if the insects are aided by the eyes in finding each other. As long as the insects are hidden in the half-frozen ground under the snow, the chances of the sexes to find one another are very remote. However, as soon as fresh snow falls, and the temperature rises (usually for one or two days) to somewhat above freezing, *Chionea* becomes strongly positive phototropic and negative geotropic. The insects seek the light, climbing up, probably not through the snow, but around tree-trunks, bushes or other places relatively free from snow, and run about, covering considerable distances. After copulation has taken place, the males die, and the females return under the snow where they are protected from extreme cold, depositing the eggs from which larvæ may develop in the spring. Possibly, the change to low temperature, as it usually occurs soon after each fresh snow-fall, will be in itself a sufficient cause for the insects, males and females, to return under the snow until the next favorable opportunity. On all of these points new observations are necessary. I wish, however, to call attention to the fact that Lugger in Minnesota (1895) has indeed observed that *Chionea* copulates on the snow, in spite of several degrees below freezing in the cases observed by him, and I found my own hypothesis confirmed by his findings. Lugger also observed that the female crawls down through a crevice in the snow and deposits her eggs which are described as elongated and yellowish, but which did not hatch.

It is to be noted in this connection that, according to T. W. Cockle (1914), also Boreus, the other well-known snow-insect, is found to copulate in mid-winter on the snow, as he observed in many instances giving a detailed account of the process; and it would be of considerable interest to know whether in Boreus there

is any special adaptation by tropism to the life on the snow, as apparently the case in *Chionea*.

The species treated here was probably Bezzi's *Chionea alpina* described by him in 1908, a few years before these observations were made. I conclude this from a comparison of my specimens with Bezzi's description, finding the characters to agree pretty closely. Characteristic for *Chionea alpina* are: the color, being yellowish but darker than in *lutescens*, the thickened femora, the stiff bristle-like hairs on the legs, showing a distinctly serial arrangement, the seven-jointed antennæ (eight in valga, nine to ten in araneoides) and the hairs on these which are, in *lutescens*, much longer than in the northern species. Moreover, the type-locality of Bezzi's species, Chiareggio, Valtellina December 8, 1899), is not very far from my locality, and separated from it only by the Engadine valley. On the other hand, Bezzi records another specimen of *Chionea alpina*, which he received from the Silvretta-glacier, likewise in the Rhætic Alps and not far from the Davos-valley. The size of my specimens ranges from 2-4 (♀ 5?) mm. in length.

As far as I know, *C. alpina* has not yet been figured, and the accompanying imperfect drawings may facilitate comparison with other species. Bezzi states that in the female of *Chionea alpina* the ovipositor is always curved upwards, a feature which, however, was absent in the specimen from Silvretta-glacier. My specimen did not show anything of this sort. Possibly, the ovipositor assumes this position after copulation has taken place or after oviposition. Another characteristic which presents some difficulty is the number of antennal joints. I believed my specimens to be six-jointed, but Bezzi gives seven joints as the number in his species, the last two joints being discernible, as Lundstroem has pointed out, by the position of the bristles. I have made some drawings of the antennæ, as accurately as possible, on which it is seen that they may be called seven-jointed, the last two joints being however fused into one.

*Note.*—One of the two male specimens still in my possession was found to have lost all its legs during transportation, showing also in this peculiarity its relationship to the Tipulids. I notice that all the legs have broken off at the trochanter, the latter remaining attached to the coxa. It seems, therefore, that there is a predisposed

place of rupture, by autotomy, at the border-line between femur and trochanter.

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<sup>1</sup>Only the more important papers are listed here. Many publications contain data on *Chionea*, its local occurrence, etc.

